Excerpted from "The Designer's Guide to High-Purity Oscillators" by Hegazi, Rael, and Abidi.
For more information, go to www.designers-guide.org/Books.

# Contents

***Chapter 1 Basics of LC Oscillators*** ..... 1
1 Introduction ..... 1
2 The Mathematical Oscillator ..... 1
3 Additive White Noise in LC Oscillators ..... 3
4 The Linear Oscillator ..... 3
4.1 Warning ..... 3
4.2 Linear System Theory Applied to Oscillators ..... 4
5 Linear Oscillator Noise Analysis ..... 6
6 How Is This Book Different? ..... 8

***Chapter 2 Oscillator Purity Fundamentals*** ..... 11
1 Introduction ..... 11
2 Timing Jitter ..... 12
3 Recognizing Phase Noise ..... 17
4 Single Sideband Contains AM and PM ..... 19
5 Phase Noise ..... 19
6 Oscillator Phase Noise Models: Post-Leeson ..... 24
6.1 Hajimiri's Model ..... 25
6.2 Demir's Model ..... 28
6.3 A Mechanistic Physical Model for LC Oscillators ..... 31

***Chapter 3 Current Biased Oscillator*** ..... 35
1 Steady-State Operation ..... 35
2 Linear Analysis of Differential Oscillator ..... 37
3 Thermally Induced Phase Noise ..... 39
3.1 Resonator Noise ..... 44
3.2 Differential Pair Noise ..... 50
3.3 Tail Current Noise ..... 57
3.4 Proving Leeson's Hypothesis ..... 62
4 Validation of Thermal Noise Analysis ..... 63

***Chapter 4 Colpitts Oscillator*** ..... 67
1 Introduction ..... 67
2 Steady-State ..... 67
3 Phase Noise Analysis ..... 72
3.1 Noise Sources ..... 72

3.2 Noise in the Resistor ..... 74
3.3 Noise of the Current Source and the Transistor ..... 78
3.4 Noise Factor of Colpitts Oscillator ..... 78
4 Conclusions ..... 80

*Chapter 5 Design for Low Thermal Phase Noise* ..... 83
1 Introduction ..... 83
1.1 Oscillator Figure of Merit ..... 83
2 Note About Harmonic Balance in LC Oscillators ..... 84
3 Amplitude in Differential LC Oscillators ..... 85
3.1 Current-Biased Differential Oscillators ..... 85
3.2 Voltage-Biased Oscillator ..... 88
3.3 Colpitts Oscillators ..... 89
3.4 Complementary Differential Oscillator ..... 94
4 Design of Current-Biased Differential Oscillators ..... 96
5 A Design Example ..... 99
5.1 Design Requirements ..... 99
6 Intuitive Explanation of Phase Noise Sources ..... 104
7 Loading in Current-Biased Oscillators ..... 106
8 Sizing of the Current Source Device ..... 109
9 Noise Filtering in Oscillators ..... 110
9.1 Role of the Current Source ..... 110
9.2 Noise Filtering ..... 112
10 Prototype Oscillator ..... 116
11 Practical Considerations ..... 119
11.1 Power Supply Rejection with Noise Filtering ..... 119
11.2 Device Limitations on Maximum Swing ..... 122
11.3 Extending the Tuning Range ..... 123
11.4 Noise Filtering in Earlier Works ..... 125
11.5 Noise Filtering in Other Oscillators ..... 126
12 Example: Redesign of GSM VCO ..... 129
13 Anatomy of the Figure-of-Merit ..... 132

*Chapter 6 Flicker Noise* ..... 139
1 Flicker Induced Phase Noise ..... 139
2 FM Due to Modulated Frequency Content ..... 139
2.1 Groszkowski in a van der Pol Oscillator ..... 142
2.2 Groszkowski in the Differential Pair Oscillator ..... 144
2.3 Critical Oscillation ..... 146
2.4 Hard Limiting ..... 149
3 Switch Voltage Noise Modulates Capacitance ..... 151
4 Frequency Modulation by the Current Source ..... 155

*Chapter 7 Design for Low Flicker Phase Noise* ..... 165
1 Introduction ..... 165
2 Flicker Noise Minimization ..... 166

3 Nulling Flicker Noise....168
4 Wideband Nulling of Flicker Noise Up Conversion....172

***Chapter 8 The Role of the Varactor*....175**

1 Fundamentals....175
2 Types of Varactors....179
3 Varactor Tuning....180
4 Analytical Evaluation of Noise Sensitivity....181
5 AM-to-FM Noise Conversion....186
6 Tuning and Supply Sensitivity....187
7 Measurements and Simulation Results....190
8 Discussion....194

Excerpted from "The Designer's Guide to High-Purity Oscillators" by Hegazi, Rael, and Abidi.
For more information, go to www.designers-guide.com/Books.